T05D05 – Enthalpy of Combustion, Neutralization, etc

Name KEY

Remember, both combustion AND neutralization are exothermic reactions. When using table 12 of your IB Chemistry Data Booklet you will find that each ΔH°_c value has a negative sign (exothermic).

1. Using the tables given out (has more than the data booklet) calculate the enthalpy change ΔH° for each of the following reactions. All are at standard conditions [298 K and 1 atm]

a. $N_2(g) + \frac{1}{2} O_2(g) \rightarrow N_2O(g)$ $\Delta H^\circ = +81.6$ kJ/mol

0 0 +81.6

b. $N_2O(g) \rightarrow N_2(g) + \frac{1}{2} O_2(g)$ $\Delta H^\circ = -81.6$ kJ/mol

+81.6 0 0

c. $2 N_2(g) + O_2(g) \rightarrow 2 N_2O(g)$ $\Delta H^\circ = +163.2$ kJ/mol

0 0 +163.2

Rules of thermochemistry are :

1. If you multiply the reaction, you must multiply ΔH as well.

2. ΔH of a rxn is $-\Delta H$ for the reverse reaction

d. $C_2H_2(g) + 5/2\ O_2(g) \rightarrow 2 CO_2(g) + H_2O(l)$ $\Delta H^\circ = -1299.6$ kJ/mol

+226.72 0 2(-393.5) -285.83

e. $HCl(g) + NH_3(g) \rightarrow NH_4Cl(s)$ $\Delta H^\circ = -175.91$ kJ/mol

-92.30 -46.19 -314.4

f. $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$ $\Delta H^\circ = +3.6$ kJ/mol

-410.9 -240.1 -167.2

g. $NH_4NO_3(s) \rightarrow N_2O(g) + 2 H_2O(g)$ $\Delta H^\circ = -36.44$ kJ/mol

-356.5 81.6 2(-241.82)

h. $NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$ $\Delta H^\circ = +28.47$ kJ/mol

-947.7 -167.2 -407.1 -393.5 -285.83

i. $MgCl_2(aq) + AgNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + AgCl(s)$ $\Delta H^\circ =$ ✗

DON'T HAVE Mg^{2+} IN THE BOOK, SKIP

aq → j. $H_2SO_4 + 2\ NaOH \rightarrow Na_2SO_4 + H_2O$ $\Delta H^\circ = -174.17$ kJ/mol

$H^+ = 0$ $Na^+ = -240.1$ $Na^+ = 2(-240.1)$

$SO_4^{2-} = -909.3$ $OH^- = 230.0$ $SO_4^{2-} = -909.3$ -285.5

Take the following word equations, change into symbols, balance and calculate the enthalpy change for each.

k. Ethyl alcohol (C_2H_5OH) ,a liquid, is burned in air to produce gaseous water and carbon dioxide.

$C_2H_5OH + 3O_2 \longrightarrow 3H_2O + 2CO_2$

-277.7 ∅ 3(-241.82) 2(-393.5) $\Delta H^\circ = -1234.76$

l. Solid chromium (III) oxide is produced (synthesized) from its elements in their standard states.

$4\ Cr + 3O_2 \longrightarrow 2\ Cr_2O_3$

∅ ∅ -1139.7 $\Delta H^\circ = -2279.4$

m Solutions of hydrochloric acid and sodium hydroxide are mixed.

$HCl + NaOH \longrightarrow Na^+ + Cl^- + H_2O$

-167.2 -496.6 -240.1 -167.2 -285.53

-407.3

$\Delta H = -56.13$